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(54) CARBONACEOUS SUBSTANCE REACTION SYSTEM AND METHOD

(57) A carbonaceous substance powder gasification system and gasification method. The system comprises a carbonaceous substance reaction apparatus and a gas return apparatus used for raising the pressure of some of a raw syngas cooled and preliminarily purified downstream of the reaction apparatus, then blending with high-temperature raw syngas upstream of the reaction apparatus and reducing the temperature. The method comprises reacting in a gasification reaction apparatus the carbonaceous substance and a gasification agent to generate raw syngas and ash and slag, some of the high-temperature raw syngas moving downstream with fly ash and liquid slag, and some of the high-temperature syngas moving upstream with fly ash; the downstream part of the high-temperature raw syngas being cooled, preliminarily purified and deslagged, then pressurized, and the wet raw syngas being injected into the system and blended with the upstream high-temperature raw syngas; the remainder of the high-temperature syngas moving upstream with fly ash and blending and cooling with the low-temperature wet syngas injected by the preliminary cooler, and optionally being entered into the cooling reaction stage; the cooled or cooling-reacted raw syngas continuing upstream, passing through the upper cooling stage and cooling again and ash being removed to obtain the raw syngas substance.

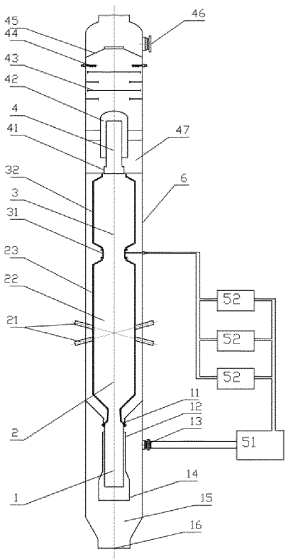


Fig. 2

EP 3 075 819 A1

Description

Field of the Invention

[0001] The present invention relates to a carbonaceous substance gasification system and method, in particularly, a system and a method to daily process more than 2000 ton of compressed pulverized coal to create synthesis gas.

Back ground of the Invention

[0002] The development of the modern petrochemical industry nowadays is more focusing on large scale production, and the clean coal pulverization technique is directed into the scale expansion of high pressure pulverization equipment. But the existing pulverization equipments all have unsolved issues.

[0003] The development of maximizing the single nozzle gasifiers is restricted by the transportation of the coal.

[0004] Multiple nozzles gasifiers utilizing synthesis gas up-flowing process can be further expanded. However, the fluid cinder is flowing in a direction which is opposite to the synthesis gas flowing direction, so the moment the fluid cinder fall into the cinder pool, it will create certain amount of low temperature steam, which also flows opposite to the flowing direction of the fluid cinder into the chamber through the cinder exit, so that the temperature of the fluid cinder drops. Therefore, when the fluid cinder unevenly falls, it's usual that the fluid cinder concretes before reaching to the cinder pool. And since the heat is not enough to melt the solid cinder, so the solid cinder accumulates until the cinder exit is blocked, which eventually causes the equipment breakdown.

[0005] Multiple nozzles gasifiers using synthesis gas down-flowing process also can be further expanded. Nevertheless, in order to fully utilizing the space in the chamber, usually the nozzles are arranged on the upper chamber where close to the top of the gasifiers, so during the reaction process, the high temperature gas and fluid cinder keeps eroding the top of the gasfiers chamber, may cause the temperature excursion on the top of the chamber so that it may potentially lead to safety issues.

SUMMARY OF THE INVENTION

[0006] One object of the present invention is to provide a large scale system of carbonaceous substance powder gasification. Another object of the present invention is to provide a method of carbonaceous substance powder gasification.

[0007] On one hand, the present invention provides a system of carbonaceous substance powder gasification, characterized in, includes a carbonaceous substance reaction device and a gas return device, said gas return device is used to mix the crude synthesis gas, which goes down from the said reaction device and has been cooled and primarily purified and then has been raised its pressure, with the high temperature crude synthesis gas which goes up from the said reaction device, so that the synthesis gas can be cooled.

[0008] The crude synthesis gas which goes down is mainly used for preventing the slagblock, at the same time, the low temperature humid synthesis gas which has been cooled is raised its pressure and fed into the primary cooling device, then it can be used as the cooling material to lower the temperature of the up going crude synthesis gas. In the present invention, the cooling material can also be water, water mist, water with the inert gas (CO2, N2), water with synthesis gas, synthesis gas. In the present invention, cooling is mainly realized by exchanging the heat with the cooling materials.Purifying is realized mainly by utilizing gravity, inertial force to separate the gas and particles.

[0009] Lowering the temperature is meant to spray in certain amount of cooling material to lower the temperature of the mixed gas till a certain point(Ex. 900 °C) ;cooling means to spray in excessive amount of cooling material, sufficiently exchanges the heat with the gas, so the temperature difference of before the cooling and after the cooling would be even bigger.

[0010] Purifying includes eliminating the dust and liquid drops in the synthesis gas , and eliminating the dust does not include eliminating water.

[0011] According to one embodiment of the present system, said carbonaceous substance reaction device includes the gasification reaction part, an upper gas outlet and a bottom gas outlet.

[0012] According to the one embodiment of the present system, part or all of the crude synthesis gas which flows out from the bottom gas outlet, after it is been cooled and preliminarily purified, flow along the pipe to the gas return device in order that its pressure is raised, and then mixes with the up going crude synthesis gas flowing out from the reaction part.

[0013] According to another embodiment of the present system, wherein the carbonaceous substance reaction device also includes a bottom cooling purify part to cool and preliminary purify the downstream high temperature crude synthesis gas which flows out from the reaction device; the inlet of the bottom cooling purify part is connected with the bottom outlet of the gasification reaction part, the synthesis gas outlet is arranged at the up middle part of the bottom cooling purify part.

[0014] The synthesis gas outlet of the bottom cooling purify part and the bottom outlet of the system can be the same one.

[0015] According to one embodiment of the present system, wherein the bottom cooling purify part also includes a rapid cooling device, a slag pool, and a slag outlet.

[0016] According to one embodiment of the present system, wherein said gas return device includes a coarse slag separator and an aerostatic press machine, the inlet of the said coarse slag separator is connected to the synthesis gas outlet of said bottom cooling purify part using

a pipe, said aerostatic press machine is used to raise the pressure of the cooled crude synthesis gas so that part or all of the gas can be inserted into the system at a pressure 0.1 MPa~6MPa higher than that the up going gas by means of the primary cooling device or by means of the upstream rapid cooling device.

[0017] At this point, the pressed crude synthesis gas has a low temperature and contains certain amount of water, so it can act as the cooling material, which can lower the energy consumption and minimize the water consumption.

[0018] According to one embodiment of the present system, the number of said aerostatic press machine can be 1 to 10, preferably 2 to 5.

[0019] According to one embodiment of the present system, said carbonaceous substance reaction device also includes a cooling down reaction part, which is set on the up middle part of the device, and its inlet is connected with the upper outlet of the gasification reaction part.

[0020] According to one embodiment of the present system, a primary cooling device is set at the inlet of the said cooling down reaction part and the upper outlet of the gasification reaction part, so that the low temperature humid crude synthesis gas, the pressure of which has been raised by the said aerostatic press machine, can be sprayed into and mix with the up going high temperature crude synthesis gas which carries flying ash. So on one hand, cooling the up going high temperature crude synthesis gas which carries ash till the temperature t2 (softening temperature of the ash), which is lower enough to make the ash to lose its viscosity, and on the other hand, supplementing the reaction substance, to further proceed the carbon gasification reaction in the ash at the cooling down reaction part, so that the hydrogen-carbon ratio of the synthesis gas can be raised. At this point, said ash is the flying ashes.

[0021] The crude synthesis gas which has been purified by the bottom cooling purity part, usually contains slag which is relatively big particle, after the slag is removed by the coarse slag separator, the crude synthesis gas which carries the water and small ash is pressed by the aerostatic press machine and transported to the primary cooling device serving as the cooling material, so it can cool the crude synthesis gas which enters into the cooling down reaction part, and take part in the cooling reaction.

[0022] According to one embodiment of the present system, said carbonaceous substance reaction device also includes a upper cooling purify part, in the scenario where in the device the cooling down reaction part is included, its inlet is connected with the upper outlet of the cooling down reaction part; while when the cooling down reaction part is not included, its inlet is connected with the upper outlet of the gasification reaction part, and is connected with the outlet of the gas return device.

[0023] According to one embodiment of the present system, said upper cooling purify part includes an upstream rapid cooling device, ash pool, and synthesis gas outlet, wherein the synthesis gas outlet is located at the up middle part of the upper cooling purity part, and the number of the synthesis gas outlet can be one or more than one, preferably 1 to 3. In the upper cooling purify device, the synthesis gas first will be rapidly cooled, then after one time or multiple times of cooling and purifying, be sent to the following procedure.

[0024] According to one embodiment of the present system, wherein the gasification reaction part has multiple nozzles which are circumferentially arranged (preferably evenly arranged), said nozzles can be arranged on one layer or multiple layers up and down, preferably 1 to 3 layers.

[0025] On the other hand, the present invention provides a method of carbonaceous substance gasification, characterized in, including the following steps:

[0026] The carbonaceous substance and the gasifying agent react in the gasification reaction part, generate the crude synthesis gas whose main components are CO and H2, and the ash and slag in which the main component is inorganic matter; one part of the high temperature crude synthesis gas goes down with flying ash and fluid slag, the other part goes up with flying ash.

I: The part of the high temperature crude synthesis gas which goes down with the ash and slag will be cooled and preliminarily purified, then be sent to the coarse slag separator, the humid crude synthesis gas, the pressure of which is raised by the aerostatic press machine, is injected into the system by means of the primary cooling device or by means of the rapid cooling device, and then mixes with the up going high temperature crude synthesis gas; the going down fluid slag will be quenched and exhausted from the equipment;

II: The rest of the high temperature crude synthesis gas goes up with the flying ash, mixes with the low temperature humid crude synthesis gas which is sprayed by means of the primary cooling device, and is cooled down to 900°C ~t2 until the ash lost its viscosity, and at the same time makes sure that the H2O which enters into the cooling down reaction part can further react with the rest of the carbon, so as to improve the carbon conversion and raise the hydrogen-carbon ratio.

[0027] After the reaction, the cooled crude synthesis gas keeps going up and passing the upstream rapid cooling device to be rapidly cooled, then enters into the upper cooling part to be cooled again and to eliminate the ash, to get the crude synthesis gas that satisfy the following procedures need.

[0028] In the detailed method of carbonaceous substance gasification, characterized in, including the following steps:

[0029] Using nozzles to spray the carbonaceous sub-

stance and the gasification agent into the gasification reaction part of the device, in the environment of high temperature (1200 °C ~ 2000 °C) and high pressure (0.1MPa~11MPa), the carbonaceous substance and the gasification agent rapidly react and generate the crude synthesis gas in which the main components are CO and H2 and the ashes and slag in which main components is inorganic substance;

[0030] Part of the high temperature crude synthesis gas and most of the ashes and slag flow down into the bottom primary cooling device, the crude synthesis gas which has been cooled and purified goes through coarse slag separator, get the big particle slag removed, is raised its pressure by the aerostatic press machine and is delivered to the cooling down reaction part, and the quenched ashes and slag are exhausted from the equipment through the slag exit, wherein, said "most of" is for instance more than 50%, preferably more than 55%, preferably more than 60%, preferably more than 65%, preferably more than 70%, preferably more than 75%, preferably more than 80%, preferably more than 85%, etc.;

[0031] Most of the high temperature crude synthesis gas and the high temperature flying ashes go up and mix with the cooling material, so they are cooled and then enter into the cooling down reaction part, at this stage, the carbon which is not fully reacted will again react with the supplemented H20, then further improve the carbon conversion and lower the temperature, and the ratio of hydrogen-carbon is also raised.

[0032] The crude synthesis gas after the reaction goes up with the flying ashes, after being rapidly cooled, goes into the upper cooling purify part, after being cooled and purified, the flying ashes in the crude synthesis gas is eliminated, so the low temperature crude synthesis gas which is relatively clean, will be sent to the following procedures.

[0033] In the present invention, said rapid reaction refers to the reaction which finishes in less than 10 seconds, 90% of the reaction finishes in 5 seconds.

[0034] The method of present invention can be proceeded in any suitable systems, preferably in the system of present invention.

[0035] The present invention with the aforementioned technical solution, has notable technical effects:

1. Since the gas return device is added, the heat efficiency is effectively improved, and the energy consumption of the device is lowered, and at the same time the system reduces the water consumption, reduces the humid and ashes in the synthesis gas, minimizes the burden for the following procedures.
2. The present invention uses a structure where the crude synthesis gas can exit from both the top and the bottom of the device, so on one hand to avoid the slagblock at the slag exit which otherwise happens when using only the upper gas exit solution, and on the other hand, to avoid the temperature excursion on the top of the device which otherwise occurs when using only the bottom gas exit solution;
3. The present invention uses multiple nozzles arrangement, which is favourable for full reaction and the maximizing of the equipment;
4. Since the cooling down reaction part is added, the carbon conversion is improved, the ratio of hydrogen-carbon is raised, and at the same time the heat efficiency of the gasification reaction is also raised.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The above and other features of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is an illustrative view of the gasification method of the present invention.
Fig. 2 is an illustrative view of a system of the present invention.

[0037] The numbers in the drawings indicate:

1. bottom cooling purify part; 11. downwards rapid cooling device; 12. downstream pipe; 13, bottom synthesis gas outlet; 14. upstream pipe; 15. slag pool; 16. slag outlet; 2. gasification reaction part; 21. nozzle; 22. gasification chamber; 23. gasification chamber water cooling wall; 3. cooling down reaction part; 31. primary cooling device; 4. upper cooling purify part; 41. upstream rapid cooling device; 42. baffle pipe; 43. baffle device; 44. spray device; 45. segregation device; 46. upper synthesis gas outlet; 47. ash pool; 5. gas return device; 51. coarse slag separator; 52. aerostatic press machine; 6. shell.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE

INVENTION

[0038] Exemplary embodiments of the present disclosure will be described hereinafter in detail with reference to the attached drawings, wherein the same reference numerals refer to the same elements.

Example 1

[0039] As shown in Fig.1, a method of carbonaceous substance powder gasification, characterize in, including the following steps:

[0040] Using nozzle 21 to spray the pulverized coal with oxygen into the gasification reaction part 2 of the equipment, in the environment of high temperature (1200°C degree to 2000 °C degree) high pressure (4.5MPa), they rapidly reacts, and creates crude synthesis gas whose main components are CO and H2 and

ashes and slag whose main components is inorganic substance.

[0041] Part of the high temperature crude synthesis gas and most of the ashes and slag flow down into the bottom cooling purify part 1, the quenched slag are exhausted from the equipment through the slag exit, the cleaned crude synthesis gas which contains water and ashes, flows through the coarse slag separator 51 to get the big particle slag removed, is raised its pressure by the aerostatic press machine 52 and is delivered to the primary cooling device 31 to serve as the cooling material and the gasifying agent.

[0042] Another part of the high temperature crude synthesis gas and the high temperature flying ashes flow up and mix with the cooling material sprayed into by means of the primary cooling device 31 to lower the temperature and then flow into the cooling down reaction part 3. The residual carbon that has not been consumed will react with the supplemented H2O in cooling down reaction part 3, which further enhance the conversion of the carbon, lower the temperature at the same time, and raise the hydrogen-carbon ratio of the synthesis gas.

[0043] After the reaction, the crude synthesis gas and the flying ash keep flowing up, is rapidly cooled, and then go into the upper cooling purify part 4, after the cooling and purifying, the low temperature relatively clean crude synthesis gas in which the flying ash has been removed, then are transferred to the next procedure.

Example 2

[0044] See Fig.2, a large scale system of carbonaceous substance gasification, characterized in, includes a carbonaceous substance reaction device, and a gas return device.

[0045] Said carbonaceous substance reaction device includes a bottom cooling purify part 1, gasification reaction part 2, a cooling down reaction part 3, an upper cooling purify part 4, and a shell 6.

[0046] Said bottom cooling purify part 1 is set at the bottom of the device, its inlet is connected with the lower outlet of gasification reaction part 2. Said bottom cooling purify part 1 includes a downwards rapid cooling device 11, a downstream pipe 12, a bottom synthesis gas outlet 13, an upstream pipe 14, a slag pool 15, a slag outlet 16, etc.

[0047] Said gasification reaction part 2 is set at the lower part from the middle of the device. Eight nozzles 21 are arranged around the periphery of gasification reaction part 2, nozzles 21 can be arranged on one layer. The bottom outlet of said gasification reaction part 2 is connected with the bottom cooling purify part 1, and its upper outlet is connected with the cooling down reaction part 3.

[0048] Said nozzle 21 is arranged so that the sprayed reactant can go in a path which creates a rotary cut (relative to the axis of the nozzle, tangent with a same circle).

[0049] Said cooling down reaction part 3 is set on the upper part from the middle of the device. Its inlet is connected with the upper outlet of the gasification reaction part. A primary cooling device 31 is arranged at the connected part, to spray a proper amount of moisturized low temperature crude synthesis gas into the crude synthesis gas, so on one hand cooling the gas, and on the other hand complementing the reactant, to further proceed the carbon gasification reaction in the cooling down reaction part, so that the hydrogen-carbon ratio of the synthesis gas can be increased.

[0050] After the reaction, the crude synthesis gas keeps going up, pass through the upper cooling purify device 4 and then is transferred to the follow up procedures.

[0051] Said upper cooling purify part 4 is set on the top of the device, its inlet is connected with the outlet of the cooling down reaction part. The going up high temperature crude synthesis gas sequentially passes through the upstream rapid cooling device 41, baffle pipe 42, ash pool 47, baffle device 43, spray device 44, segregation device 45, upper synthesis gas outlet 46, etc. so it can be cooled, moisturized, and purified (moisture and ash are removed).

[0052] Said gas return device 5 includes a coarse slag separator 51, an aerostatic press machine 52 etc. The inlet of the said coarse slag separator 51 is connected via pipe with the synthesis gas outlet 13 of the bottom cooling part 1. The number of the aerostatic press machine 52 can be one or more than one, preferably three. The crude synthesis gas which has passed through the bottom cooling part 1, still contains big particle slag. After the big particle slag has been removed by the coarse slag separator 51, the crude synthesis gas which contains moisture and fine particle ash will be pumped by the aerostatic press machine 52 to the primary cooling device 31, so it can be used as the cooling material to cool off the crude synthesis gas which enters into the cooling down reaction part and take part in the cooling reaction.

Claims

1. A system of carbonaceous substance powder gasification, **characterized in**, includes a carbonaceous substance reaction device and a gas return device, said gas return device is used for mixing the crude synthesis gas which flows down from the said reaction device and is cooled and preliminarily purified and then is raised its pressure, with the high temperature crude synthesis gas which flows up from the said reaction device.

2. The system of carbonaceous substance powder gasification according to claim 1, wherein, said carbonaceous substance reaction device includes a gasification reaction part, a top gas inlet, and a bottom gas outlet.

3. The system of carbonaceous substance powder gasification according to claim 2, wherein, part or all of the crude synthesis gas which flows out from the bottom gas outlet, after being cooled, preliminarily purified, flowing along the pipe and passing through the gas return device to be raised pressure, then mixes with the upgoing crude synthesis gas which flows out of the reaction part.

4. The system of carbonaceous substance powder gasification according to claim 1, wherein, said carbonaceous substance reaction device also includes a bottom cooling purify part, to cool and preliminarily purify the down going high temperature crude synthesis gas flowing out of the gasification reaction part; the inlet of the bottom cooling purify part is connected with the bottom outlet of the gasification reaction part, the synthesis gas outlet of the bottom cooling purify part is at the up-middle part of the bottom cooling purify part.

5. The system of carbonaceous substance powder gasification according to claim 4, wherein the bottom cooling purify part also includes a rapid cooling device, a slag pool, and a slag outlet.

6. The system of carbonaceous substance powder gasification according to claim 1, wherein said gas return device includes a coarse slag separator and an aerostatic press machine, the inlet of the said coarse slag separator is connected to the synthesis gas outlet of said bottom cooling purify part using a pipe, said aerostatic press machine is used to raise the pressure of the cooled crude synthesis gas so that part or all of the gas can be inserted into the system at a pressure 0.1 MPa~6MPa higher than that of the up going gas by means of the primary cooling deviceor by means of the upstream rapid cooling device.

7. The system of carbonaceous substance powder gasification according to claim 6, wherein, the number of said aerostatic press machine can be 1 to 10, preferably 2 to 5.

8. The system of carbonaceous substance powder gasification according to any of the claims 1-7, wherein, said carbonaceous substance reaction device also includes a cooling down reaction part, which is set on the up middle part of the device, and its inlet is connected with the upper outlet of the gasification reaction part.

9. The system of carbonaceous substance powder gasification according to claim 8, wherein, the inlet of the said cooling down reaction part includes a primary cooling device, said primary cooling device is set at the inlet of the said cooling down reaction part and the upper outlet of the gasification reaction part, so that the low temperature humid crude synthesis gas, the pressure of which has been raised by the said aerostatic press machine, can be sprayed into and mix with the up going high temperature crude synthesis gas which carries ash, so on one hand, cooling the up going high temperature crude synthesis gas which carries ash till the temperature 900 °C ~t2 (softening temperature of the ash), which is lower enough to make the ash to lose its viscosity, and on the other hand, supplementing the reaction substance, to further proceed the carbon gasification reaction in the ash at the cooling down reaction part, so that the hydrogen-carbon ratio of the synthesis gas can be raised.

10. The system of carbonaceous substance powder gasification according to claim 8, wherein said carbonaceous substance reaction device also includes an upper cooling purify part, its inlet is connected with the upper outlet of the cooling down reaction part.

11. The system of carbonaceous substance powder gasification according to claim 10, wherein said upper cooling purify part includes an upstream rapid cooling device, ash pool, and synthesis gas outlet, wherein the synthesis gas outlet is located at the up middle part of the upper cooling part, and the number of the synthesis gas outlet can be one or more than one, preferably 1 to 3.

12. The system of carbonaceous substance powder gasification according to claim 2 or 3, wherein the gasification reaction part has multiple nozzles which are evenly and circumferentially arranged, said nozzles can be arranged on one layer or multiple layers up and down, preferably 1 to 3 layers.

13. A method of carbonaceous substance powder gasification, **characterized in**, including the following steps:

the carbonaceous substance and the gasifying agent react in the gasification reaction part, generate the crude synthesis gas whose main components are CO and H2, and the ash and slag in which the main component is inorganic matter; one part of the high temperature crude synthesis gas goes down with the flying ash and fluid slag, the other part goes up with the flying ash;

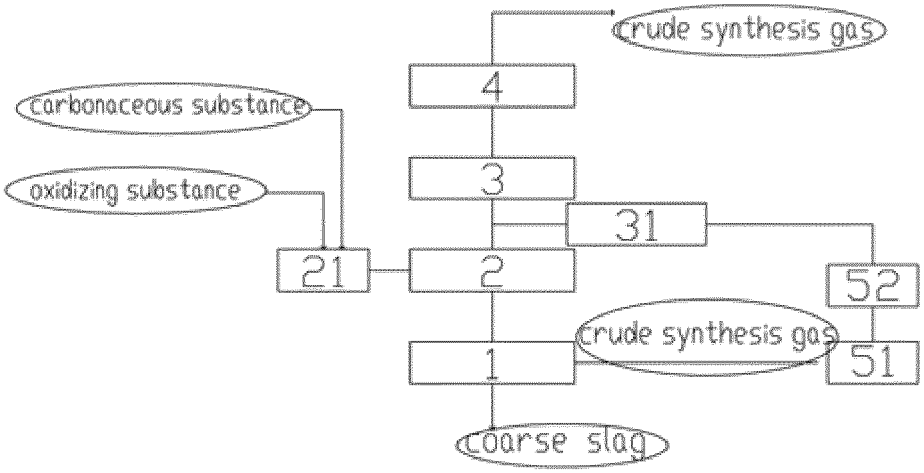
I: The part of the high temperature crude synthesis gas which goes down with the ash and slag will be cooled and preliminarily purified, then be sent to the coarse slag separator; the humid crude synthesis gas , the

pressure of which is raised by the aerostatic press machine, is injected into the system by means of the primary cooling device or by means of the rapid cooling device, and then mixes with the up going high temperature crude synthesis gas; the going down fluid slagwill be quenched and exhausted from the equipment;

II: The rest of the high temperature crude synthesis gas goes up with the ash, mixes with the low temperature humid crude synthesis gas which is sprayed by means of the primary cooling device, and is cooled down to 600 °C ~t2 until the ash lost its viscosity, optionally enters into the cooling down reaction part;

Preferably, the preliminarily cooled crude synthesis gas can further react with the rest of the carbon in the cooling down reaction part, to improve the carbon conversion and raise the hydrogen-carbon ratio;

the cooled crude synthesis gas keeps going up and enters into the upper cooling part to be cooled again and eliminate the ash, to obtain the crude synthesis gas that satisfy the following procedures need.


Crude synthesis gas
4
Carbonaceous substance
3
oxidizing substance
31
21
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52
Crude synthesis gas
1
51
Coarse slag

Fig. 1

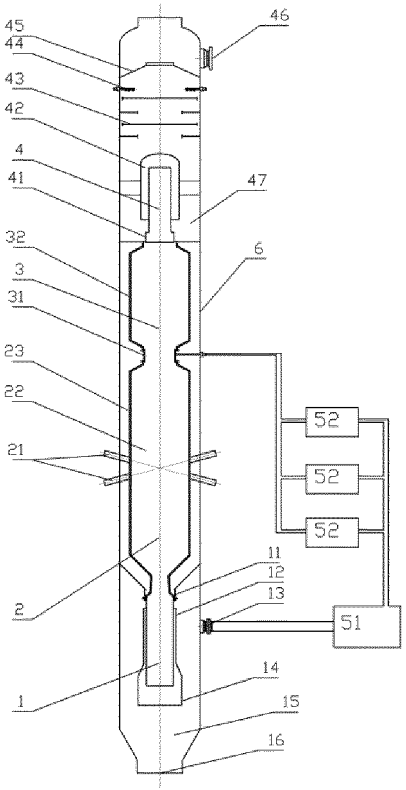
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Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/091839

A. CLASSIFICATION OF SUBJECT MATTER

C10J 3/48 (2006.01) i, C10J 3/84 (2006.01) i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C10J 3/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: gasifi+, upward+, downward+, cool+ reaction, cool+, quench+, purif+, synthetic gas, slag, ash, cycl+, return, turn

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 203700293 U (AEROSPACE LONG MARCH CHEM ENG CO., LTD.) 09 July 2014 (09.07.2014) claims 1 to 11, and description, paragraphs [0023] to [0028]	1-13
PX	CN 203700292 U (AEROSPACE LONG MARCH CHEM ENG CO., LTD.) 09 July 2014 (09.07.2014) description, paragraphs [0007] to [0029]	1-13
A	CN 101570699 A (BEIJING AEROSPACE WANYUAN COAL CHEM ENG TECHNOLOGY CO., LTD.) 04 November 2009 (04.11.2009) description, page 2, the first paragraph, and figure 1	1-13
A	CN 201842827 U (HUISHENG ENG CHINA CO., LTD.) 25 May 2011 (25.05.2011) the whole document	1-13
A	CN 102827640 A (CHINA SHIPBUILDING IND CORP 711TH RES) 19 December 2012 (19.12.2012) the whole document	1-13

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 February 2015	03 March 2015
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer HAN, Fanzhen Telephone No. (86-10) 62084854

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/091839

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DD 217236 A1 (BRENNSTOFF FREIBERG) 09 January 1985 (09.01.1985) the whole document	1-13

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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